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NASA Engineers Crush Giant Fuel Tank to Improve Rocket Designs

By Kenneth Kesner

Think of it as high-tech can crushing. Only the can is enormous, as big as part of the largest rocket ever made.

During a series of tests that began Dec. 9 and will conclude Dec. 13 at NASA's Marshall Space Flight Center, engineers are applying nearly a million pounds of force to the top of an empty, but pressurized, rocket fuel tank. The test will eventually buckle and destroy the structure of the thin, cylindrical tank wall while instruments precisely measure and record everything, millisecond by millisecond.

"What we learn will make it possible for NASA to design safe but still thinner and lighter structures for the Space Launch System and other spacecraft," said Dr. Mark Hilburger, senior research engineer in the

*See **Engineers Crush Tank** on page 2*

Dr. Lisa Watson-Morgan Appointed Manager, Office of the Chief Engineer, in Marshall's Engineering Directorate

Dr. Lisa Watson-Morgan has been appointed to the Senior Executive Service position of manager, Office of the Chief Engineer, in the Engineering Directorate of NASA's Marshall Space Flight Center.

In her new role, Watson-Morgan will be responsible for assuring the technical excellence and success of all Marshall spacecraft, propulsion,

*See **Lisa Watson-Morgan** on page 3*

Lisa Watson-Morgan (NASA/MSFC/Fred Deaton)

Engineers Crush Tank

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Structural Mechanics and Concepts Branch at NASA's Langley Research Center.

If engineers can make tanks stronger but lighter, rockets can carry heavier payloads to space. That's the goal of the Shell Buckling and Knockdown Factor Project led by the NASA Engineering and Safety Center (NESC) in collaboration with Marshall and Langley teams.

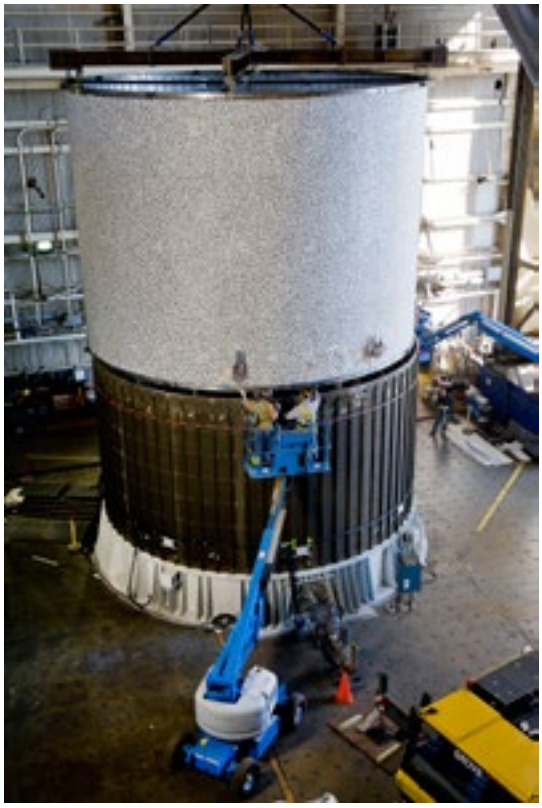
They are conducting their second full-scale tank test, nicknamed Can Crusher II, in Marshall's unique facility designed to test the full-size structures. Marshall engineers involved in the testing have a keen interest in the results because the data will enhance the design of the heavy-lift Space Launch System, which is being developed by Marshall and will be the largest, most powerful rocket ever built.

"This is my first large-scale structural test," said Matt Cash, lead test engineer. "It's a fantastic experience, and everything I'm learning helps me prepare for SLS structural testing." Cash earned a degree in civil engineering with an emphasis on structures from the University of Alabama in Tuscaloosa. He's been a NASA employee at Marshall for three years.

Because Marshall is one of the few places in the world where this kind of testing can be done, Cash said he's thrilled to be in the right place at the right time. "The tests will provide extremely valuable data to SLS. I couldn't be happier to get to be a part of it," Cash said.

Since 2007, the Shell Buckling Knockdown Factors Project has been using cutting-edge test and analysis techniques to develop a new, extremely accurate set of factors or design standards for NASA and the aerospace industry, which have been using data that dates back to Apollo-era studies.

In March 2011, the project team came to Marshall for what they believed to be the first test-to-failure of a full-scale, 27.5-foot-diameter, 20-foot-tall aluminum lithium test cylinder just for research purposes. It was reinforced with an orthogrid stiffener pattern, and the team squeezed it until it buckled, revealing the edges of the design margin.



Engineers position a 27.5-foot-diameter cylinder for the first full-scale Shell Buckling and Knockdown Factor Project test held at the Marshall Center in March 2011. Engineers are now conducting a second series of tests that conclude on Dec. 13, crushing a similar cylinder until it buckles and gathering data to develop new design standards for lighter rocket tanks. The test article, built at Marshall from panels used for external tanks in the space shuttle program, is speckled with markers used by a digital image correlation system. Cameras positioned around the tank monitor the movement of the dots during testing. (NASA/MSFC/Emmett Given)

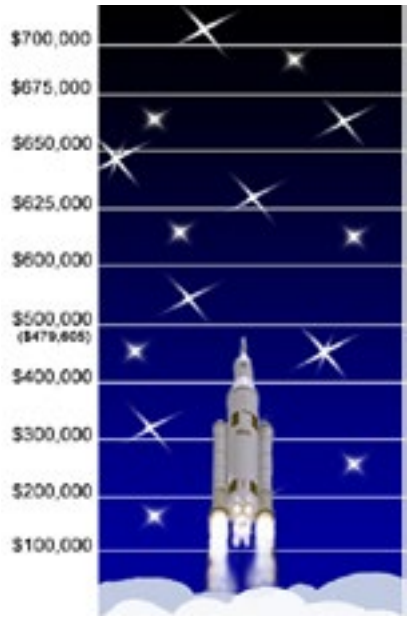
The cylinder being tested this time is External Tank-derived Test Article 2, or ETTA 2. Like ETTA 1 in 2011, it was built at Marshall from panels used for external tanks in the space shuttle program. This one is also 27.5 feet in diameter, the same diameter as SLS tanks, and 20 feet tall, but will feature a different orthogrid stiffener pattern.

"Using the heritage tank panels and Marshall's valuable test facilities is saving millions in test dollars and time," Hilburger said.

Kesner, an ASRC Federal/Analytical Services employee, supports the Office of Strategic Analysis & Communications.

Don't Forget CFC as You Countdown to the Holidays

While contributions to the Marshall Space Flight Center's annual Combined Federal Campaign charity drive officially crossed two-thirds of the way to the final goal, the contribution rate slowed over the past week. The current total raised or pledged is $479,605, which is 68.5 percent of the $700,000 goal the campaign hopes to achieve by Jan. 15, with just over a third -- 35 percent -- of the Marshall workforce participating. CFC organizers are asking everyone, even during the hectic holiday period, to remember those less fortunate by visiting the CFC page on ExplorNet to learn how to help the many charities in need, either through financial contributions or volunteering your time.



Lisa Watson-Morgan

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science payload, life support, and mission systems. She will provide expert technical leadership in planning, directing, and executing research, technology, ground and flight systems design and development, production, integration, and sustaining engineering for the Space Launch System program, the Flight Programs and Partnerships Office, and the Science and Technology Office, as well as other projects in the Human Exploration and Operations and Science mission directorates.

Watson-Morgan has served in the senior level position of Chief Engineer, Flight Programs and Partnerships Office, Office of the Chief Engineer, Engineering Directorate, since September 2011. She was responsible for technical excellence and implementing technical authority for the center across programs and projects in all three NASA mission directorates.

She began her NASA career at Marshall in 1989 as a cooperative education student. When converted to a permanent employee, she served in the Mission Operations Laboratory as a data management controller for the ATLAS-3 Spacelab mission. In 1995, she became lead for the Operations Utilization Team, heading Kaizen efforts for the ground operations processes and working ground operations requirements within the Huntsville Operations Support Center for Spacelab, the International Space Station and the Space Shuttle Program. In 2005, she was promoted to Ground Systems Operations branch chief.

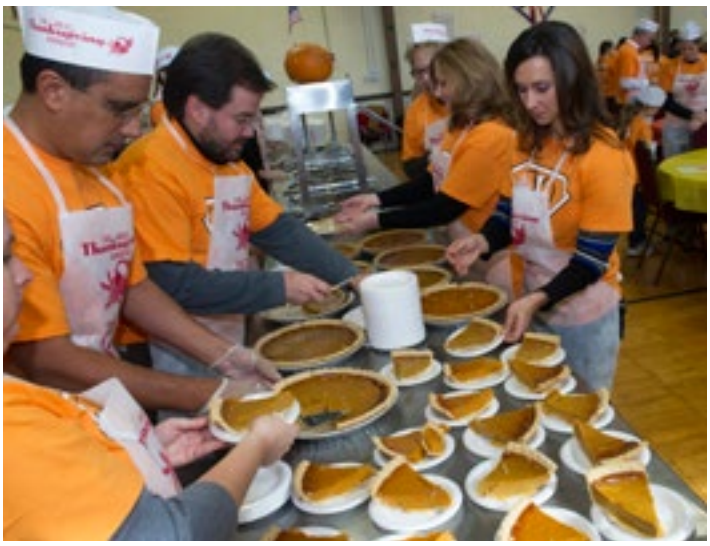
Watson-Morgan served as assistant chief engineer for the Science and Mission Systems Chief Engineers Office from April 2008 to November 2009, supporting the pre-phase A International Lunar Network, the FASTSAT HSV01 microsatellite development and space station payloads and hardware, as well as Department of Defense efforts. She was detailed to the Science and Mission Systems Project Office as acting assistant manager from November 2009 to August 2010, performing strategic planning and project management, including the integration of and process for all International Space Station Engineering Research & Technology Demonstrations for Marshall. From August 2010 to August 2011, she served as acting chief engineer, Science and Mission Systems.

She earned a bachelor's degree in industrial engineering from the University of Alabama in Tuscaloosa in 1991, and both master's and doctoral degrees in industrial and systems engineering from the University of Alabama in Huntsville, in 1994 and 2008, respectively.

Watson-Morgan has been the recipient of the NASA Exceptional Service Medal, the NASA Exceptional Achievement Medal and numerous special service and group achievement awards.

Marshall Center Investing in Mankind through CFC

Tereasa Washington, director of the Marshall Space Flight Center's Office of Human Capital, right, assists Lauren Badia, at far left, an engineer with Marshall's Spacecraft & Vehicle Systems Department, serve Thanksgiving meals at the Downtown Rescue Mission in Huntsville. Washington and other Marshall Center team members volunteered at the mission cafeteria as part of Marshall's Combined Federal Campaign Community Service Days. (NASA/MSFC/Emmett Given)



Employees and support staff from Marshall's Office of Human Capital prepare to serve pumpkin pie as part of the Thanksgiving meal at the Downtown Rescue Mission in Huntsville. The volunteer effort was part of CFC Community Service Days when Marshall Center team members are encouraged to help one of the many non-profit organizations in the Madison County area. To see the full schedule and list of organizations or to sign up for a shift at an area charity supported by CFC, visit the CFC ExplorNet page. (NASA/MSFC/Emmett Given)

Marshall Astrophysicist David Hathaway Confirms Existence of Giant Convection Cells on Sun

By Kenneth Kesner

A NASA Marshall Space Flight Center astrophysicist has confirmed the existence of giant convection cells -- approximately 200,000 kilometers in diameter -- flowing slowly on the sun, lending further insight into the transport of heat from its core and the origin of cycles of sunspot activity that affect essential satellite-based communications such as cell phones and TV broadcasting.

The rapid movement of smaller convection cells -- granules and supergranules about 1,000 and 30,000 kilometers in diameter, respectively -- have long been observed through telescopes and other instruments. The existence of giant cells comprised of the smaller ones was proposed in 1968 after the discovery of supergranules, said Dr. David Hathaway, an astrophysicist at the Marshall Center. But because they are so large and move so slowly, the giant cells have eluded scientists.

In a paper published Dec. 6 in the journal *Science*, Hathaway details how, in the summer of 2013, he and co-authors Lisa Upton and Owen Colegrove used data from the Helioseismic and Magnetic Imager on NASA's Solar Dynamics Observatory to observe the movement of giant convection cells. The observatory was launched in February 2010.

*See **Convection Cells on Sun** on page 6*

Marshall Student Interns Prepare Exhibit of Famous Goddard Rocket

By Tracy McMahan

It is one of the most famous rockets in American history: the first liquid-fueled rocket, designed and built by Robert Goddard in 1926. This fall, Goddard's rocket helped the next-generation of rocket engineers learn about propulsion.

In 2003, engineers at NASA's Marshall Space Flight Center constructed a functional replica of the 1926 Goddard rocket to mark the U.S. Centennial of Flight, 100 years after the Wright Brothers' historic flight. For the last decade, the model was displayed in Marshall's test area, but this year it got a new life. Student interns working the fall semester for Marshall's Engineering Directorate turned the model into a display that will become an exhibit, so others can learn about the famous rocket.

"I've often seen the classic picture of Goddard and his rocket in textbooks," said Cameron McCarty, an intern majoring in astrophysics and planetary geology at Columbus State University in Columbus, Ga. "Working with the rocket was an eye-opening experience because I could see the details Goddard had to consider when building the rocket."

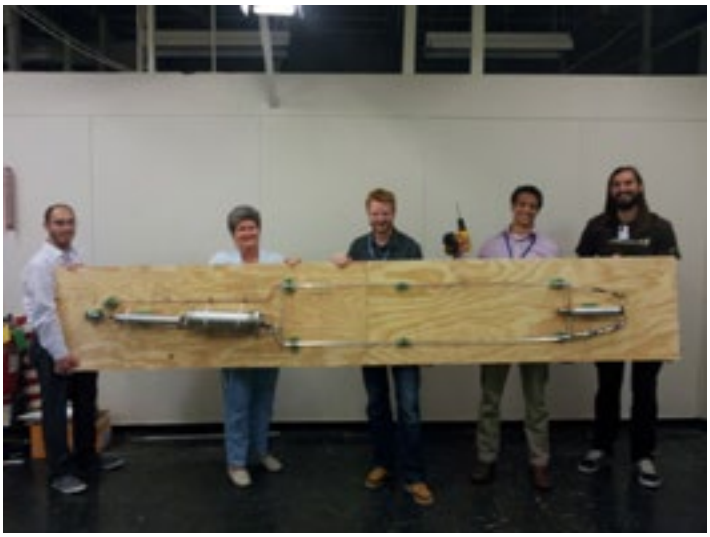
The rocket model at Marshall is the only known functional replica of Goddard's rocket. It was test fired in July 2003 in the Marshall East Test Area. You can learn more about the 2003 Goddard Rocket Replica Project here.

"It was great to study such a simple model of a liquid rocket engine," explained Ryan Hatton, an intern majoring in aerospace engineering at Virginia Tech in Blacksburg. "Seeing only the minimum components needed to build a rocket engine helps you understand the concept. It's much easier to grasp than something as complex as the space shuttle main engine."

That's why Marshall systems engineer Becky Farr thought creating the display would be a great learning experience for the students and volunteered to mentor them as they created the exhibit.

"The Goddard rocket consists of all of the functional components necessary for every liquid rocket built since 1926," Farr said. "I wanted the interns to understand that Robert Goddard built it to validate his mathematical models of rocket propulsion through testing."

*See **Goddard Rocket** on page 7*



A display of Robert Goddard's famous rocket assembled by Marshall interns, from left, Carolos Mendoza, intern from Texas A&M University; Becky Farr, Marshall systems engineer and intern mentor; Cameron McCarty, intern from Columbus State University; Ryan Hatton, intern from Virginia Tech; and Chris Tellesbo, intern from the University of Utah. (NASA/MSFC/ Chris Tellesbo)

Mentors Needed for Summer Internships

NASA's Marshall Space Flight Center interns volunteered their time to construct the Goddard rocket display. These interns' main assignments are in the Engineering Directorate's Spacecraft and Vehicle Systems Department, which leads a variety of efforts from helping to build the Space Launch System to tracking meteorites.

"This is the kind of experience that makes a NASA internship, and specifically an internship at Marshall, so unique," said Mona Miller, who heads the internship program in Marshall's Academic Affairs Office.

The office is seeking mentors for summer interns. The program began accepting mentor opportunity descriptions and student applications on Nov. 1. Marshall employees interested in participating can find out more at http://intern.nasa.gov or by contacting Mona Miller at mona.miller@nasa.gov or Tina Atchley at tina.c.atchley@nasa.gov.

'Tis the Season for the 2013 Marshall Center Holiday Celebration on Dec. 12

The Marshall Exchange is getting ready to deck the halls for the 2013 Marshall Space Flight Center Holiday Reception. On Dec. 12, all Marshall team members are invited to the Activities Building 4316 from 3-5 p.m. to celebrate the holiday season.

Door prizes will be given away and winners must be present to win. Musical entertainment will be provided by Marshall team members Matt Smith, Robert Polsgrove, Richard Stroud, and Lawrence Jones, all of the Propulsion Systems Department; David Hohn, Chief Engineers Office; Andres Almeida, Office of the Deputy Director; Carlos Barreto, Spacecraft & Vehicle Systems Department; and Wayne Gamwell, Materials & Processes Laboratory. The Trinity Handbell Quartet from Trinity United Methodist Church in Huntsville will ring in the entertainment finale.

Festive food and spirits will be available to guests, and astronaut T.J. Creamer will join in the celebration as well.

Convection Cells on Sun

Continued from page 4

"The key to this was that we were able to get continuous observations that are only available from space and from this instrument," Hathaway said.

They looked at the motion of supergranules hourly over several 27-day solar rotations with the expectation that they would be carried from the centers to the boundaries of giant cells by the slow but long-lived flow.

When the data was examined, the movement of giant cells became obvious on the computer screen. "It just jumps right out at you," Hathaway said. "We knew immediately."

The findings end an intermittent quest for the scientist, who has been with NASA for 29 years. In 1975, Hathaway was a graduate student with a summer internship at Sacramento Peak Observatory in New Mexico. There he worked with George Simon, who, with Nigel Weiss, theorized the existence of the giant cells in 1968. Part of that summer was spent looking for their giant cells, Hathaway recalled, but "we didn't have the data at the time."

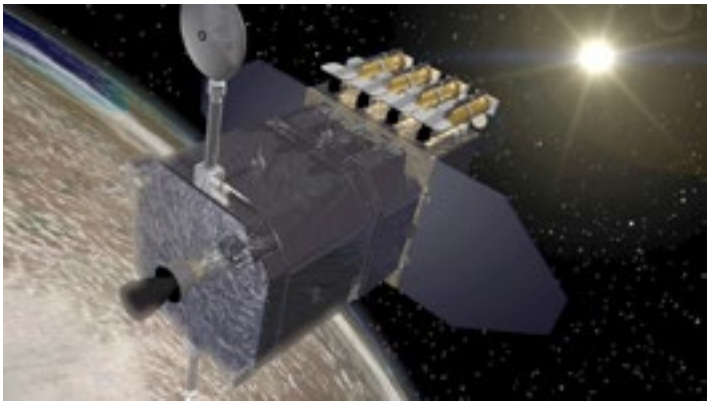
Researchers have confirmed the existence of giant convection cells flowing slowly on the sun, lending further insight into the origin of cycles of sunspot activity. In a paper published in the journal Science, Marshall astrophysicist Dr. David Hathaway, right, and co-authors Lisa Upton, center, a graduate student at Vanderbilt University; and Owen Colegrove, an undergraduate at the University of Rochester, describe how they used data from NASA's Solar Dynamics Observatory to observe the movement of giant convection cells. (NASA/MSFC)

*See **Convection Cells on Sun** on page 7*

Convection Cells on Sun

Continued from page 6

He continued looking over the years as he conducted other research and new instruments became available to study the sun. In 1996, Hathaway applied a mathematical technique he developed to information gathered by the Michelson Doppler Imager aboard the European Space Agency / NASA Solar and Heliospheric Observatory, which was launched the previous year. But the evidence for giant convection cells was still just circumstantial, a tantalizing hint "something was there that's big. They were moving with the sun's rotation," said Hathaway, "but I couldn't tell you what they look like."



A team of researchers led by astrophysicist Dr. David Hathaway of NASA's Marshall Space Flight Center used data from the Helioseismic and Magnetic Imager on NASA's Solar Dynamics Observatory to confirm the existence of giant convection cells on the sun. (NASA)

Now he can. In 2013, another summer intern, Owen Colegrove of the University of Rochester in New York, was assigned to work in Hathaway's office at the National Space Science and Technology Center in Huntsville. Colegrove joined Lisa Upton, a graduate student at Vanderbilt University in Nashville who has worked with Hathaway since the fall of 2010, and is employed by the University of Alabama in Huntsville.

"I said, 'Let's go look for giant cells,'" Hathaway said. "It worked this time."

Now, they'll be looking at how the giant cells affect the formation of magnetic field structures on the sun, among other research. "It could help us with longer-term predictions of how big a sunspot cycle is going to be," he said. "We may be able to look at these flows and identify areas where new sunspots are going to emerge, before we see them on the sun's surface. That's one of the key hopes of researchers who have looked at this in the past."

The new findings may also help answer a question asked since the time of Galileo, a father of modern astronomy, who pointed his telescope at the sun in the 1600s: Why does material at the sun's equator rotate more rapidly than at the poles? At the equator it takes about 25 days to go around once, but at the higher latitudes it takes about 35 days.

"You need some kind of mechanism to drive that action," Upton said, and many theories have been proposed. Some process must cause flows near the equator to move in the direction of rotation, and flows farther from the equator to move in the opposite direction.

"These giant cells do that," Hathaway said, and the authors address the issue in their paper. The rotation is a key part of how the sunspot cycle works, and has implications for every star, he said. The theory has been there for years, but the observation was lacking.

"We're in the midst of a scientific revolution within the solar community on how the sunspot cycle works," Hathaway said.

Kesner, an ASRC Federal/Analytical Services employee, supports the Office of Strategic Analysis & Communications.

Goddard Rocket

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"It is amazing that you can learn basic concepts of kinematic mechanics and wave mechanics from such a simple rocket," said Carlos Mendoza, an intern majoring in physics at Texas A&M University at Commerce.

The rough-hewn display has been handed over to the Marshall exhibits group in the Office of Public & Employee Communications. They will upgrade it for future display. Now, thanks to the Marshall fall 2013 interns, many others will be able to view and enjoy the simplicity of Goddard's famous first rocket that he called "Little Nell."

McMahan is a public affairs officer in the Office of Strategic Analysis & Communications.

Supernova Blast Provides Clues to Age of Binary Star System

From NASA news release

Data from NASA's Chandra X-ray Observatory has revealed faint remnants of a supernova explosion and helped researchers determine Circinus X-1 -- an X-ray binary -- is the youngest of this class of astronomical objects found to date.

(X-ray: NASA/CXC/Univ. of Wisconsin-Madison/S.Heinz et al; Optical: DSS; Radio: CSIRO/ATNF/ATCA)

As the name suggests, X-ray binaries are star systems made up of two parts: a compact stellar remnant -- either a neutron star or a black hole; and a companion star -- a normal star like our sun. As they orbit one another, the neutron star, or black hole, pulls in gas from the companion star. This heats the gas to millions of degrees producing intense X-ray radiation and making these star systems some of the brightest X-ray sources in the sky.

Sebastian Heinz and his team at the University of Wisconsin-Madison (UW) discovered Circinus X-1 is less than 4,600 years old, making it the youngest X-ray binary system ever seen. This discovery, made in parallel with a radio telescope in Australia, provides scientists unique insight into the formation of neutron stars and supernovas, and the effect of the supernova's explosion on a nearby companion star.

Astronomers have detected hundreds of X-ray binaries throughout the Milky Way and other nearby galaxies. However, these older X-ray binaries, with ages typically measured in millions of years, only reveal information about what happens much later in the evolution of these systems.

To determine the age of Circinus X-1, the team of astronomers needed to examine the material around the orbiting pair of stars. However, the overwhelming brightness of the neutron star made it too difficult for researchers to observe the interstellar gas. The team recently caught a break, when they observed the neutron star in a very faint state -- dim enough for scientists to detect the X-rays from the supernova shock wave that plowed through the surrounding interstellar gas.

The youth of Circinus X-1 helps explain its wild swings in brightness and the highly unusual orbit of its two stars which had puzzled astronomers for years. The orbit is very eccentric -- non-circular -- and the period during which the two stars orbit each other is decreasing by several minutes every year. This is exactly what is expected for a young X-ray binary disrupted by a supernova explosion before the gravitational pull of the stars on each other has had time to circularize and stabilize the orbit.

Previous observations with other telescopes indicated the magnetic field of the neutron star in Circinus X-1 is weak. That, in addition to the star system's young age, has led to two possible theories: either a neutron star can be born with a weak magnetic field, or it can quickly become de-magnetized as it pulls material from its companion star onto itself. Neither conclusion was expected from existing theories of neutron star evolution.

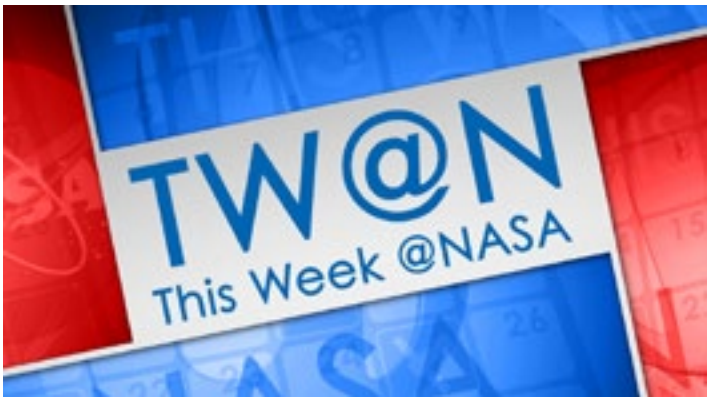
NASA's Marshall Space Flight Center manages the Chandra program for NASA's Science Mission Directorate in Washington. The Smithsonian Astrophysical Observatory in Cambridge, Mass., controls Chandra's science and flight operations.

For more information about Chandra, visit: http://www.nasa.gov/chandra and http://chandra.si.edu.

NASA's New Rover Challenge Featured on NASA-TV

The announcement that NASA's Great Moonbuggy Race is evolving into NASA's new Human Exploration Rover Challenge is featured in the latest edition of "This Week @NASA," a weekly video program broadcast nationwide on NASA-TV and posted online. The new engineering design challenge is intended to engage students in the next phase of human space exploration.

Registration is open to high school and college student teams around the world, challenging them to create a vehicle designed to function in a wide variety of environments, not just Earth's moon. Their scientific results and findings will inform the design process for NASA's next generation of space systems.



You can watch this edition of This Week @NASA at the NASA-TV YouTube channel.